EcoAqua meeting,
28-30 October 2019, Bogor, Indonesia

Trophic Functioning Of Integrated Rice Agriculture to Fish Aquaculture In Madagascar: Insights From Stable Isotopes ($\delta^{13}C$ & $\delta^{15}N$)

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Trophic functioning of Rice-Fish farming

On of the oldest Integrated Aquaculture to Agriculture (IAA) system

about 2000-year-old, in China

popularized in Madagascar by **FAO** in (1985) and **APDRA** (since 2006)

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Trophic functioning of Rice-Fish farming

A promising IAA in Madagascar Highlands,
Rice-Fish association is promoted in a low-input context

- Main crop and staple food
- Production lower than demand
- Low and vulnerable incomes

- Save space and water
- Save money (low fertilizers and feeds)
- Provide fish to fight against food insecurity

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Trophic functioning of Rice-Fish farming

Wild fish **traditionally** trapped in irrigated rice fields (Wild Tilapia)

→ **Improvement** through farmed fish and water management

- Common Carp
- Raised bunds
- Refuge channel

	J	A	S	O	N	D	J	F	M	A	M	J
Rice (120 d)												
Fry												
Fish (150 d)												

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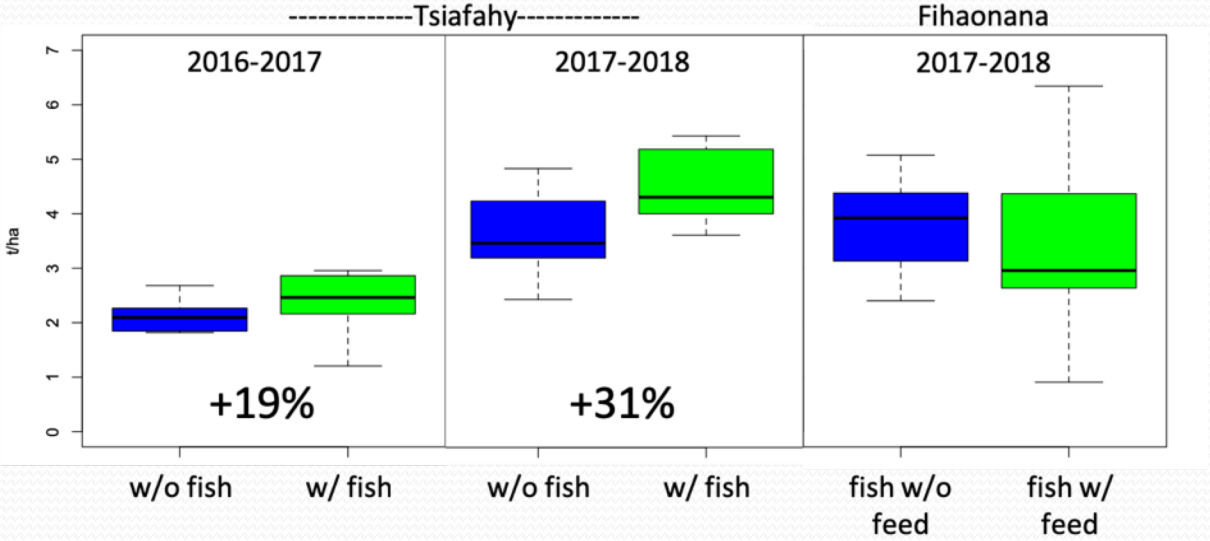
Rice-Fish farming in Madagascar



Mortillaro & Dabbadie, In Press, FAO

Improvement of **rice yield** with fish largely compensating for the **10%** surface lost by **refuge channel** (Kutty, 1987)

How do fish impact rice yields?

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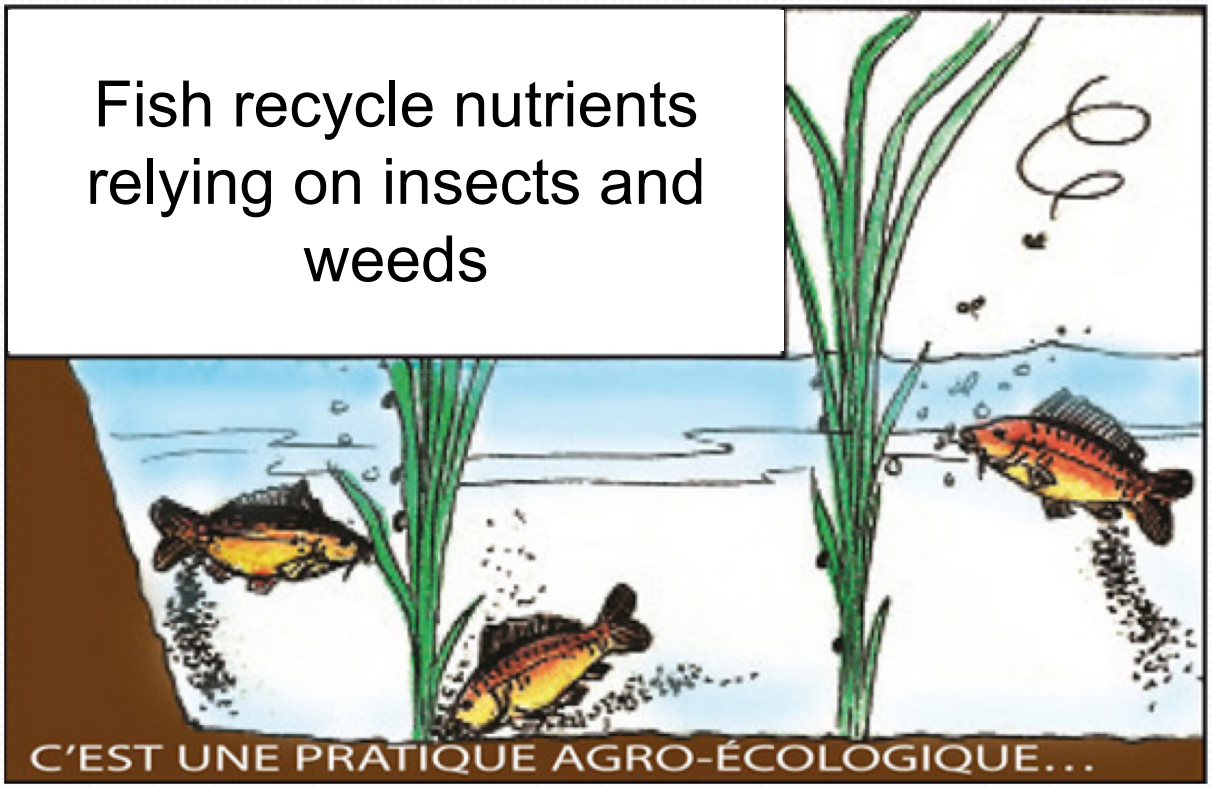
Trophic functioning of Rice-Fish farming



Adapted from APDRA Manual, 2015

Rice-fish ecosystems much more complex than single weeds and insects

Feeding behavior of common carp in rice-fish systems ?

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Rice-Fish farming in Madagascar

Natural carbon and nitrogen stable isotopes

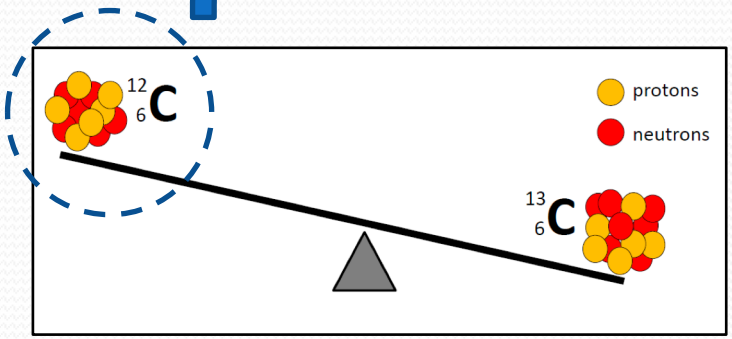
Stables isotopes: atoms of same chemical elements which differ in their number of neutrons, where no decomposition occurs over time (e.g. ^{12}C, ^{13}C, ^{14}N, ^{15}N)

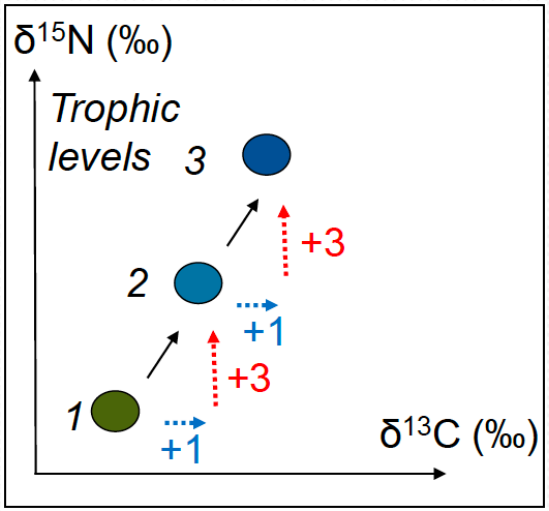
Measurement of the isotopic ratios by Mass Spectrophotometry

$^{12}C/^{13}C$ ➔ **$\delta^{13}C$**

$^{14}N/^{15}N$ ➔ **$\delta^{15}N$**

Respiration of the lighter isotope





Adapted from Nahon *et al.*, 2017, EAS, Dubrovnik

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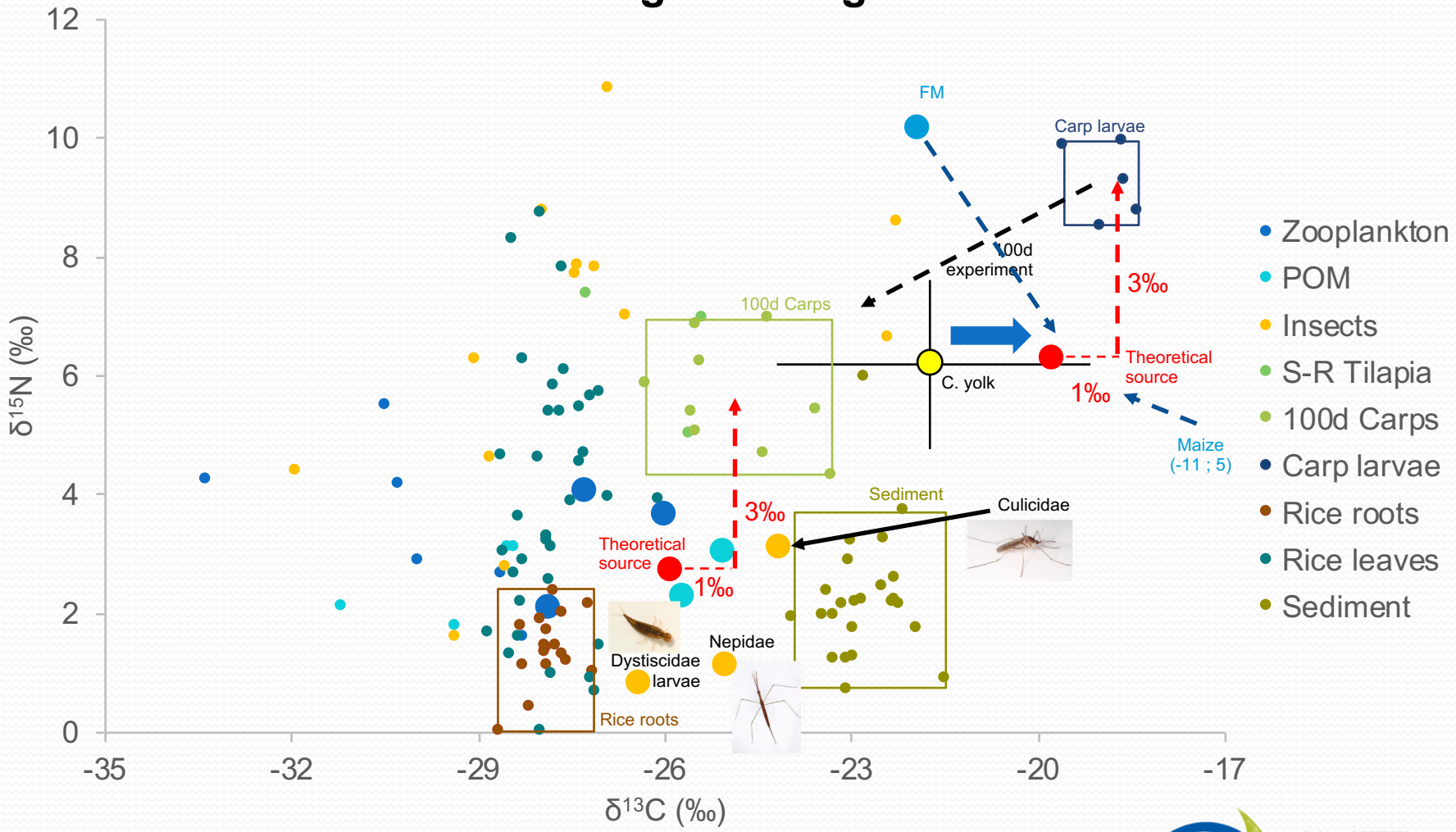

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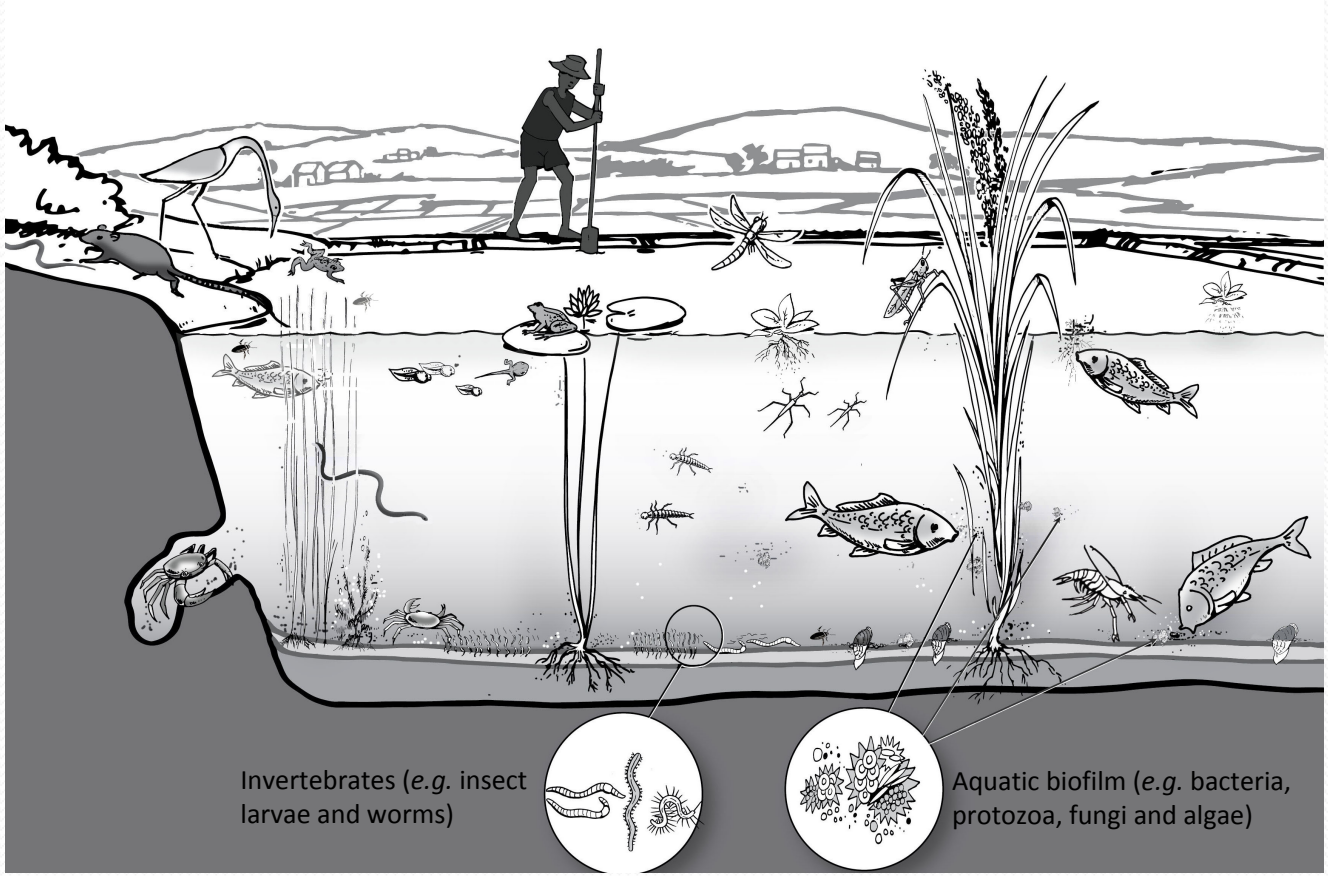
Rice-Fish farming in Madagascar



Mortillaro & Dabbadie, In Press, FAO

In **extensive** systems, **common carp** forage on the **natural diversity** of rice fields

Impact of common carp should not be limited to nutrient recycling

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Trophic functioning of Rice-Fish farming

- Common carp **excretion** is the primary mechanism affecting **nutrient dynamics** (Matsuzaki *et al.*, 2007)

- **Bioturbation** of common carp increase **oxygen supply in soils** (Ritvo *et al.*, 2004)

- Common carp are **ecosystem engineers** affecting the **water transparency** and **community composition** (*e.g.* phytoplankton, submerged macrophytes, zooplankton; Matsuzaki *et al.*, 2007)

➔ Carp impact extensive rice-fish systems:

- Fighting against rice pests (feeding or environment)
- Improving soils quality (bioturbation)

How to promote agro-ecological intensification of rice-fish system?

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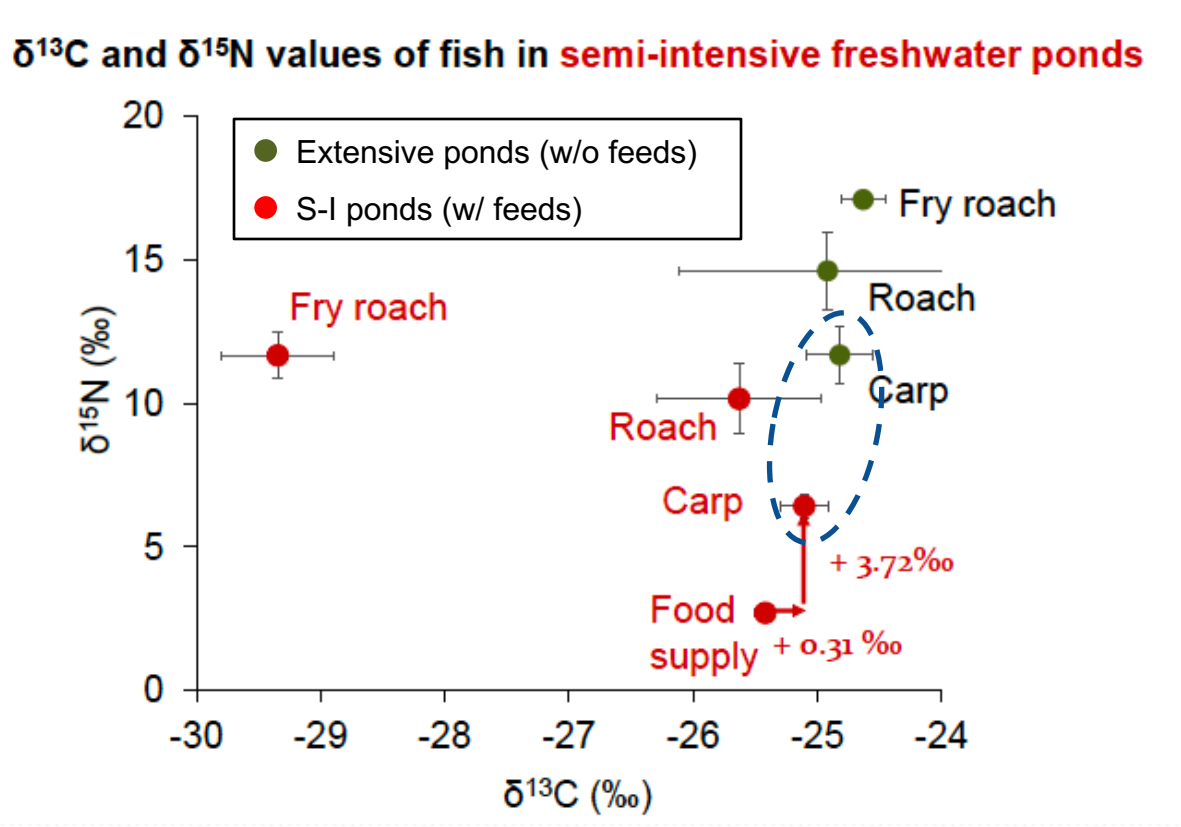

Nahon *et al.*, 2017, EAS, Dubrovnik

1) **Feeds** may only impact **nutrient excretion**

2) Enhancing **natural productivity** (fertilization) will promote impact of **common carp** on **ecosystem functioning**

Opportunisms of Common Carp:
With **feeds**, **carp** will **exclusively** rely on food supply

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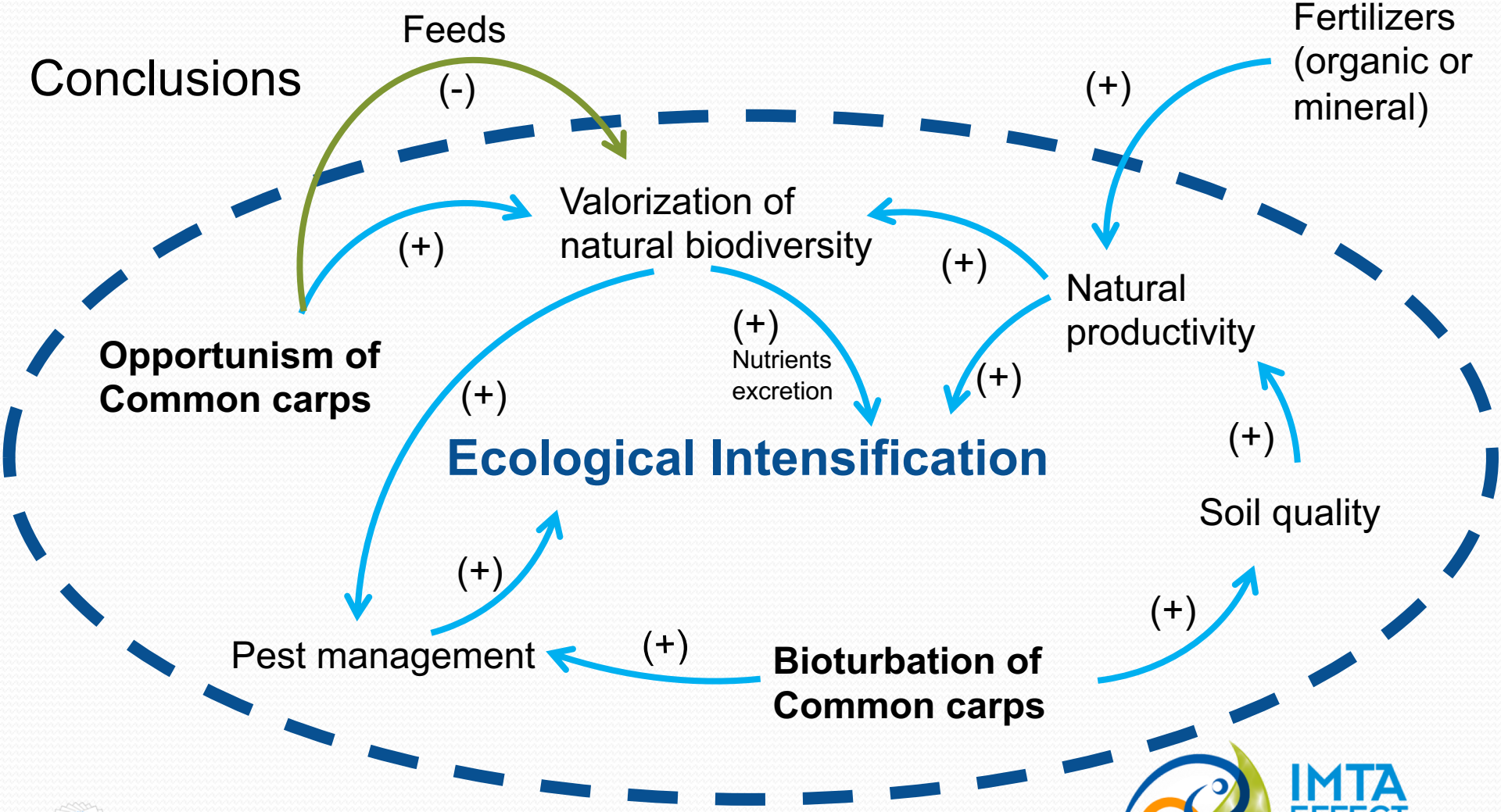

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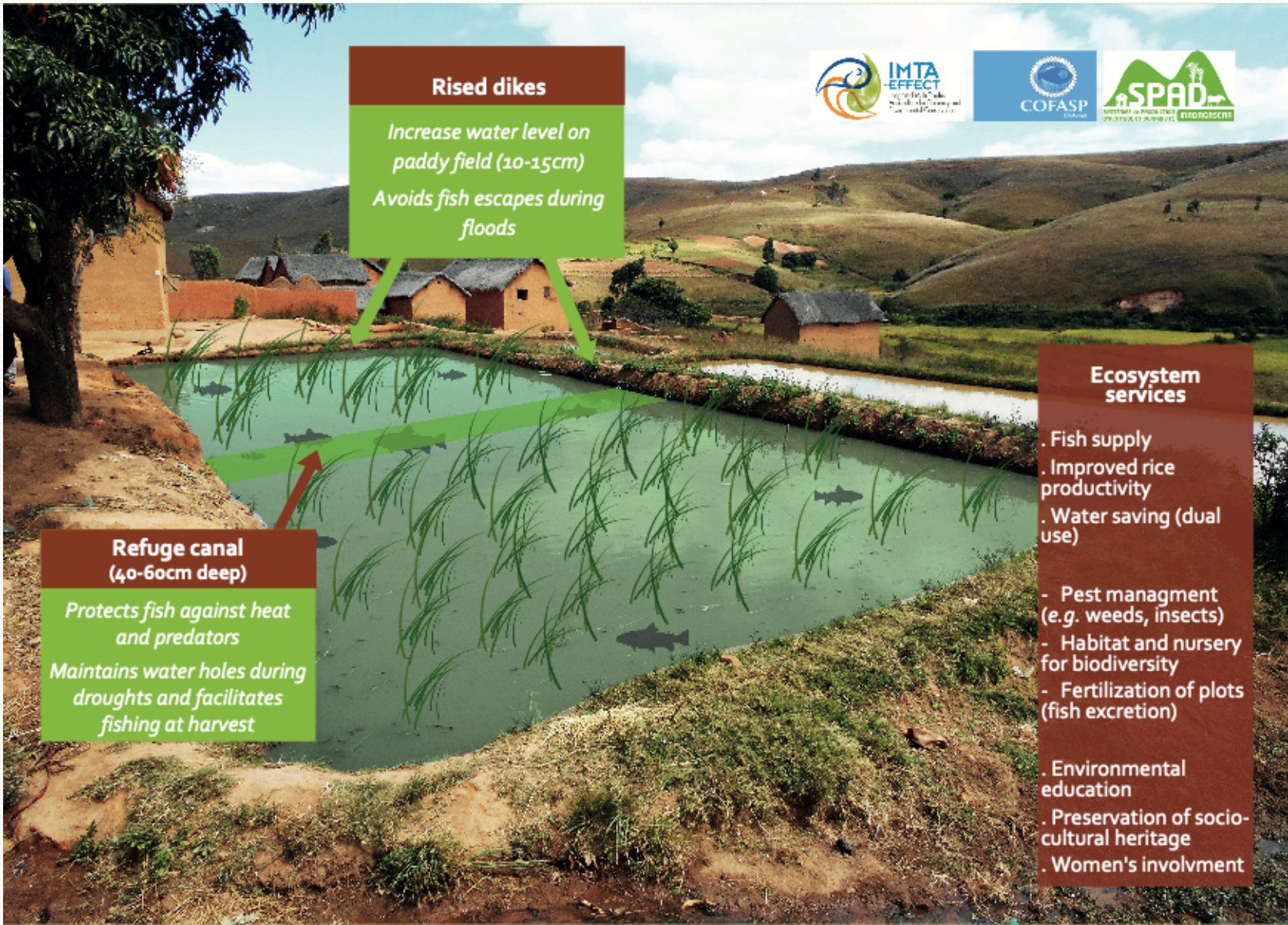

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Thanks You